STAGE 2 CONTRACT REPORT

Contract Reports. Methods for determining the benefits of safety audit. A scoping study
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TRANSIT NEW ZEALAND CONTRACT 95/12:

BENEFITS OF SAFETY AUDIT

STAGE 2 REPORT

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(1) INTRODUCTION

This research project aims to determine and summarise the benefits of Safety Audit, and - if appropriate - carry out research on specific, selected topics.. At the outset no assumptions were made about possible topics; it was intended that these arise during the progress of the research project and the list and be studied and refined as the research project progressed. It was, however, made clear in the brief that hese benefits would include not only the more obvious benefits such as a reduction in injury collisions on projects which have been audited, but also much wider benefits such as, for example, improved design practice.

The project has been set up in three stages; stage 1 being the broad identification of potential benefits, stage 2 being the categorisation of those topics with a suggested methodology for determining the benefits of each.

Stage three will include the actual carrying out of studies on aspects of safety audit and associated benefits, which appear to promise useful results.

The stage 1 report was written following a 'round table' discussion and was simply a summary of the potential topics. This (stage 2) report develops the list of stage 1 topics partly derived at the round table meeting, and partly from other sources, suggests methods of research each of the identified potential benefits and includes information provided in answer to letters seeking information from overseas persons known to have been active in this field.

Following further discussion and analysis it is intended that stage 3 will include research on aspects which appear to hold a promise of useful and cost-effective results.

(2) POTENTIAL BENEFITS

2.1 Benefits identified from discussion and information received

The following potential benefits of safety audit (table 1, over)were identified as part of stage 1 of this project. Additional potential benefits resulting from a study of the replies received from other authors and authorities are added to these. (see appendix)

Table 1 - Potential benefits of Safety Audit

(1)	Minimising the risk and severity of accidents that may be created by the road project at the site and on the adjacent network:
(2)	Minimising the need for remedial works after construction;
(3)	Reducing the whole life costs of the scheme;
(4)	Improving the awareness of safe design practices including in other professions);
(5)	Increasing skills in road safety engineering;
(6)	Better management of schemes (from design to on going operation);
(7)	Contributing to achieving road safety goals;
(8)	Contributing to improved standards
(9)	Better facilities for vulnerable road users;
(10)	Contributing to more efficient use of funds;
to which may be added	
(11)	Improving knowledge and increasing data base (and hence confidence in prediction of benefits)
(12)	Contributing to the function of networks from the traffic calmness and environmental points of view

2.2 *The process of Safety Audit*

The process of safety audit itself was not listed as a benefit, being a means to an end. However, if safety audits are not carried out efficiently then the benefits will not be achieved in full measure, or - worse - potentially hazardous features may be incorporated into the scheme as built. It is therefore necessary to examine this aspect under the broad heading of effectiveness.

The process of actually carrying out the safety audit was described in the stage 1 report as follows (in table 2 over):

Table 2 - The process of Safety Audit

(1)	Identification of problem >
(2)	Information given to designer >
(3)	Acceptance by designer >
(4)	Correction of plans >
(5)	Correct building of the changed feature.

The method of assessing the efficiency of each stage in table 2 will be described later. The topic is introduced here not because it is necessarily more important than measuring the benefits, but because it is the first action of the safety audit process and in a time sequence it should logically be dealt with first.

It was also felt necessary to justify its presence in the following table. It would be possible to carry out a study of the benefits of safety audit without assessing the process, but the efficiency of safety auditing is a fundamental 'building block' of the process and this seems an opportunity to save time and effort by including it in this study of benefits rather than launching a separate process.

2.3 Allocation of topics on the basis of how to assess them

Three kinds of topic

Three types of topic have been identified:

(1) Those relating to the process itself

(2) Those which are capable of producing direct numerical statistical results.

(3) Those which are the subject of opinion or answers to questionnaires

The topics listed in Tables 1 and 2 have been allocated to the three types as follows (in table 3, over), with the addition of a related topic, the cost efficiency of safety audit:-

Table 3 - allocation of topics to three main types

Related to the process (P)	Numerically measurable (M)	Matters of opinion (O)
(1) Identification of problem (2) Information to designer (3) Acceptance by designer (4) Correction of plans (5) Correct building of the changed feature. 6) Cost efficiency of safety audit	(1) Minimises the risk and severity of accidents that may be created by the road project at the site and on the adjacent network (2) Minimises the need for remedial works after construction (3) Reduces the whole life costs of the scheme (4) Contributes to achieving road safety goals; (5) Contributes to improved standards (6) Better facilities for vulnerable road users	(1) Improve the awareness of safe design practices (including in other professions); (2) Increased skills in road safety engineering (3) Better management of schemes (from design to on going operation); (4) Contributes to more efficient use of funds; (5) Improved knowledge and data base (6) Contributes to the function of networks from the traffic calmness and environmental points of view

Note: in the above table the table 1 topics have been re-numbered so that, for instance, (9) becomes M(6).

Discussion

While some of the placements are obvious, several listed under (O) would be capable of numerical assessment if a kind of test or examination were carried out. This would be unusual and difficult to apply uniformly over a large sample of designers, and could well be unpopular, and therefore resisted or rendered meaningless. However, it would be possible to include a selection of appropriate questions in a survey of designers designed to ascertain the influence of safety audit.

In attempting to describe possible ways of measuring the benefits each of the topics listed in Table 3 will be described in some detail. The recommendation of a selection of topics and methods will be described at the end of the report.

(3) THE EFFECTIVENESS OF THE PROCESS

Topics in this category, listed under 'P' in table 3, include:

(1) Identification of problem
(2) Information to designer
(3) Acceptance by designer *(and client)*
(4) Correction of plans
(5) Correct building of the changed feature

Where a scheme is subjected to more than one safety audit, any matter not dealt with at an earlier audit which reappears later is evidence of inefficiency.

The Safety Audit Manager has a list of the sample of safety audits carried out by Transit New Zealand to 1 July 1994 for which a return to him was required. There is no such requirement for schemes selected by Regional Managers or local authorities so it seems necessary to write to each manager to obtain a list of safety audits for which full records have been kept.

The use of safety audit by local authorities is a matter for a separate study. It might be possible to sample safety audits and assess the efficiency of application. In the case of Christchurch City and Manukau City Councils (who have internal safety audit systems), discussions with the safety auditors and assessment of the acceptance of their recommendations might be worthwhile.

3.1 Suggested methodology for assessing the internal efficiency of the process (method a - relates to topics P1-P5)

From whatever authority safety audits are selected for review, a statistically reliable sample will need to be chosen to represent the categories described in 'Safety Audit Policy and Procedures 1993'. The categories listed are (a) under $100,000, (b) $100,000 - $5,000,000 and (c) over $5,000,000. It may be necessary to preclude the over $5,000,000 category through lack of valid non safety audited schemes.

Each of the points (P1) to (P5) will need to be examined in each case in conjunction with the designer and client. It will be necessary to obtain copies of the original design, the safety audit recommendations and copies of the corrected and 'as-built' plans. A 'post audit - post construction' site safety audit should be carried out on a representative sample.

After site inspection, a brief report on the 'effectiveness' in achieving 'benefits of safety audit' for each site will be prepared.

Just what difficulties will be found in recovering old information, or resistance by designers is uncertain. Before this method is applied fully, a trial investigation of, say, three design stage safety audited schemes should be carried out in the Christchurch area to (a) determine if it is a worthwhile method (and deficiencies have been found), and (b) to correct the method to get rid of any problems encountered. As part of a full study three un-audited schemes of similar nature should be investigated for comparison and benefit assessment purposes.

If the results from a local trial are inconclusive and the Safety Audit Manager feels it worth while to widen the study it is suggested that additional schemes be investigated from a wider area.

(It may be convenient to divide the country into three areas centred on the three major cities and regions well served by experienced safety auditors:

(1) The north of the North Island (ie North of a line from Taranaki to Gisborne)

(2) The south of the North Island (south of that line)

(3) The South Island.)

3.2 The efficiency of the process in internal B/C terms (method b - refers to P6)

A further topic has been added to the 'process' topic; the cost efficiency of safety audit. If the study is satisfactorily to gauge the efficiency of safety audit, it should be possible to demonstrate that the value for the cost of a typical safety audit is greatly outweighed by the benefits. This is often assumed but has never, to my knowledge, been assessed in New Zealand. Studies have been carried out on this topic in Denmark (see appendix). A start can be made by sampling safety audits and assessing typical staff and overhead costs using, say, typical charge out and vehicle operating rates.

The build up of knowledge of the benefits described elsewhere in this report can then be applied to determine an 'internal B/C ratio'.

(4) THE ACCIDENT REDUCTION BENEFITS RESULTING (M1)

4.1 The method proposed by Bruce Corben, Monash University, Accident Research Centre (method c)

As listed in the appendix section 2, his 'brief thoughts' on an approach to the evaluation of safety audit are as follows:

- take a group of road projects and subject them independently to both processes, ie with and without safety auditing;
- identify significant differences in the planning and design outputs of both processes and in the input, capital and recurrent costs of both processes;
- estimate the future crash rate of the unaudited outcomes for each project, based on typical crash rates for roads of similar type;
- estimate the safety consequence of the significant differences, where possible using the results of past evaluations to estimate the crash change). Where there are no past evaluations to draw on, best estimates would need to be made;
- these estimates could then be used to estimate the crash savings due to safety auditing, and the costs of achieving them, enabling some sort of economic evaluation to be carried out.'

Comment. It would be necessary to expand and clarify this methodology. The estimation of future crash rates on unaudited schemes requires statistical justification and a workable methodology. To some extent this has been expanded in the 'Surrey method' described below.

4.2 *The method developed and used by Surrey County Council, UK (method d)*

A methodology derived from that developed in the County of Surrey United Kingdom should be developed and trialed. (Appendix section 4.)

The following is a draft proposal based on that system and adapted to New Zealand conditions.

4.2.1 Site Selection, Surrey Method (d)

The sites used to represent those having had safety audits shall be the same as those selected in compliance with clause 3.1 above. The objective of this aspect of the study is as follows:-

The measurement of the changes in the reported injury and non injury crash rate compared to non safety audited schemes

The method to be trialed should be broadly similar to that used in the County of Surrey, UK, (see appendix), but should include major schemes in addition to the minor works type of project used in Surrey.

4.2.2 Data and analysis; Surrey Method (d)

The record of reported injury and non-injury crashes will be obtained for each site for a period of (ideally) five years before the scheme was implemented, and for as long a period as possible after. Changes in the type, average severity and location or clustering will be listed and expressed and plotted on a plan of the site in comparison to non safety audited sites.

The record of reported injury and non-injury crashes for all sites selected before and after completion will be determined and analysed. Where the network is significantly changed, such as by the introduction of a by-pass, a special methodology may be needed (see 3.6 below)

Any oddities in the record of reported injury and non-injury crashes will be carefully analysed and in particular clustering of crashes - and their type - identified.

Some schemes will have had safety audits conducted at more than one stage. It is the intention of safety audit that all **problems** not previously identified be identified and corrected at the design stage safety audit. It will be worthwhile checking to see if any problems in an earlier audit have not been dealt with. The other matter of concern will be for schemes which have had a so-called pre-opening safety audit, at which previously identified or completely new **problems** were identified and corrected.

Interest will then centre on whether pre-opening safety audits are worthwhile. It may be argued that all schemes are checked in the field before the site ceases

to be a construction site. However, the precise opening time is blurred by the practice of allowing traffic through sites but subject to temporary control. Often schemes will have all construction signs removed and be open to traffic before any site check (if any) is undertaken. This is probably a separate topic but the potential difficulties are flagged here as having some relevance to this study. Just how to handle this situation may emerged from pilot studies.

4.2.3 Selection of comparison sites (ie non safety audited, Surrey method d)

A similar number of such sites will be selected initially for a Canterbury based trial, and if found appropriate, for each of the three areas of New Zealand listed in section 2.1. It may be necessary to discount the larger (over $5,000,000) sites through lack of sites and the work required being excessive for the potential result. The sites will be selected from a list of completed schemes in each area on a random basis, but choosing schemes for which a similar before and after construction period applies, compared to the selection of safety audited schemes.

A possible problem has been identified in that sites suitable for safety audit are selected on the basis of perceived need or potential benefits. Sites not selected are deemed to be more straight forward or of potentially less of a problem from the nature of the design. However, this may be overcome to some extent by looking at the relative rather than absolute changes in the record of reported injury and non-injury crashes.

4.3 Method of comparison (any methodology, a, b, c &/or d)

For comparison purposes the current value for fatal, serious injury, minor injury and non injury accidents will need to be applied using the methodology described in the 'Project Evaluation Manual' of Transit New Zealand. This also involves a factor related to the speed limit, the area in which the scheme lies, and the different reporting rates for each type of injury. This appears to involve a complex process but in looking for probably quite small changes, it is essential to use a scientific approach in order to give confidence in the results.

A problem may arise due to the random occurrence of fatalities. For instance, a head on collision could involve several fatalities. This could occur before or after - even during construction and make the assessment of 'risk' meaningless on a single scheme basis. It would be hoped that the inclusion of an adequate number of schemes would handle this situation but it may still be preferable to exclude fatalities or treat them as serious injury 'accidents'.

The results will be expressed either in equivalent total injury numbers (factoring the figures by adding up all costs and dividing be the average cost per reported injury and non-injury crash), or in dollar terms. In either case, the figure (equivalent crashes or total costs) will also be expressed per million vehicle movements through the scheme.

4.4 *Need for a trial or trials of selected methods*

Before committing full staff and time resources to a sufficient number and range of schemes to give statistical confidence, it is recommended that three representative schemes with safety audits, and three representative schemes without, be studied in the central South Island area, if possible trialing methods a-d or whichever is selected in discussions between the researcher and the Safety Audit Manager. The three schemes would be chosen to suit the range of costs described in the report 'Safety Audit Policy and Procedures" August 1993./

Following this trial, there is a choice of action:

(a) In any method trialed, discontinue the process. This would be done if the method failed to yield meaningful results and/or unforseen difficulties arose which could not be remedied.

(b) Modify the process and re-test locally. If possible select a methodology which includes useful elements of methods a - d and produce one combined method

(c) Modify the process and conduct limited tests nationally - and if successful conduct sufficient to give statistical confidence or,

(d) Confirm the process and conduct larger scale national tests.

4.5 *Records of accidents - a national data base*

It will be necessary to adopt a national record of reported injury and non-injury crashes on or related to safety audited schemes. This is described under O5 - clause of this report

5. (N2) MINIMISING THE NEED FOR REMEDIAL WORKS

The most practical immediate way of determining this is to include a question in a questionnaire to be distributed to designers. See later in this report.

It is possible, even likely, that remedial works have been carried out by the road controlling authority without the knowledge of the designers. A study such as this will, over a period of years, remedy this lack of knowledge.

Remedial works will range from minor - but important - actions such as installing edge delineation, to major physical changes. Any difficulties in determining what post construction changes have been made is a matter for study. For instance, just how closely edge delineation is specified in a design is an open question - its omission might not be the fault of the designer. This is also a point which needs to be checked.

To be true to the intention of this study, it will be necessary to carry out a similar investigation into remedial works on a selection of schemes which have **not** been safety audited.

If this aspect of the assessment of benefits fails to yield a useful and reliable answer, it would be wise to monitor a new safety audit or audits from beginning

to opening, and on into the future. Naturally it would be essential not to reveal to the road controlling authority which scheme or schemes had been chosen. A site visit routine might need to be established, but access to records of works carried out (possibly including costs) might be more reliable. It would be necessary to exercise judgment as to what constituted remedial work compared to routine maintenance, or to do with premature failure of the infrastructure (foundations, kerbs, inadequate drainage etc). (This brings up an interesting point as to how these other aspects of the process are checked. Might a design standard audit prevent premature failure of part of the scheme?)

6. (N3) REDUCING THE WHOLE LIFE COST OF SCHEMES

It seems likely that this point cannot be checked as part of a study which is taking place after an almost insignificant part of the whole life of schemes.

Any trends should become apparent as the years go by, with reference to a data base. To be useful in this instance it would be necessary to include the cost and date of remedial works. Whether the effort is justified and how it can be achieved are matters which might become clearer as this study progresses.

This study should be tied in to monitoring remedial works. All matters to do with traffic management of the scheme would need to be included, and matters to do with the maintenance or failure of the structure or foundations excluded. There is a 'grey area' in which safety audit corrections result in a sounder design from other points of view. See O6 below for whole network potential benefits.

7. (N4) CONTRIBUTING TO ACHIEVING ROAD SAFETY GOALS.

To measure the effect of safety audit in achieving local or national road safety goals it will be necessary to isolate the records of reported injury and non-injury crashes on safety audited roads and compare these to the total.

There appears to be little prospect of producing much more than a local appraisal in the short term. However, if a safety audited major scheme results in a dramatic drop in reported injury and non-injury crashes, this could be a matter for a separate study. The concern of this report is the possibility that such a scheme resulted in a bigger drop in reported injury and non-injury crashes than would otherwise be the case. In any event, it would not be possible to produce a confident answer without covering the whole area of influence of the scheme and calculating or discounting phenomena such as 'accident migration'

8. (N5) CONTRIBUTING TO IMPROVED STANDARDS.

This is not a matter for a relatively short term study and would be difficult to isolate from all the other influences on the intent and wording of standards. Possibly a question in a survey could determining the perceived contribution of safety audit to the improvement of standards.

Alternatively those responsible for up-dating standards could be asked to report any changes which have resulted from a safety audit. It would also be interesting if a significant change resulted from reported failings which are

commonly identified in safety audits (see reports on the Review of Safety Audit, 1995)

One of the factors to consider is whether standards are continuously upgraded or dealt with by a major re-write from time to time. In the latter case an assessment on safety audit originating changes could possibly be made.

9. (N6) BETTER FACILITIES FOR VULNERABLE ROAD USERS.

This is a point which could be measured as part of the study of a selection of safety audited schemes compared to a selection of non-audited schemes. It would probably be worthwhile dealing with the point as a separate study, or at least ensuring that the person doing the checks was alert to the need to make a specific list of **problems** related to the provision of facilities for vulnerable road users. The term is taken to include children, the elderly, the mobility impaired, blind or deaf people.

Although not really part of this study, facilities for cyclists and pedestrians might be worth separating out for special study in any comparison between schemes which have been audited and those which have not. Pedestrian facilities in particular will be of concern to vulnerable road users.

10. (O1-3) MATTERS OF OPINION.

Five matters have been listed under this heading. The first three seem to lie squarely in the realm of opinion, unless - as already mentioned - a kind of written test were carried out. It therefore seems appropriate to deal with the first three items together:

10.1 (O1) Improving the awareness of safe design practices including in other professions);

(O2) Increasing skills in road safety engineering

(O3) Better management of schemes (from design to on going operation);

Written tests of knowledge or competency are often carried out in trades (for example in the armed forces or as apprenticeships progress) but do not feature in engineering professions including both professional and certificate of engineering personnel, after passing the professional interview or final examination. Other than including some kind of oblique questions in a questionnaire, such a trade or knowledge test seems difficult to conduct.

It could be argued that most designers are reasonably well aware of the specific needs which go to producing a safe design but for one reason or another get details wrong or omit a safety feature - even assume that somebody else will pick up the problem (eg edge delineation not being specified). On the other hand, the art and science of traffic design has changed over the years from being an add-on to the general practitioner - the county of borough engineer, for example. Nowadays the designer has to be aware of a whole host of technical and practical requirements, but there are still loud and vigorous arguments

between traffic engineers about not only the details but often the fundamental basis of a design.

Perhaps this study will throw some light on the safety differences of such different approaches, but probably not in a formal way. It could be that this study, like safety audit itself, might prompt some hard thinking about safety rather than capacity aspect of design.

If a national data base is set up it might be possible to discern a gradual improvement in design, both in audited and un-audited schemes.

The spreading of the knowledge or acceptance of safe design practices into other professions - or lay persons or politicians - will probably always remain a matter of opinion. Perhaps the greater acceptance of the need to spend a little more on safer schemes by the holders of the purse strings - ie administrators rather than pure engineers - will confirm the acceptance of the process. One can conjecture that the ultimate test might be to accept schemes at a lower B/C cut off point where a safety audit has been carried out. The logic for such a preference is difficult to argue, but concern has been expressed that schemes with safety audits might become so much more expensive that they fall below the cut off point. It can be argued that if such a scheme had been built with all the faults revealed by the audit present, then it would fail to achieve the benefits predicted. The original B/C is a false one, the new one the correct one.

I suggest that a study of this point would be a worthwhile inclusion in a broad study of the benefits of safety audit, if only to dispose of this particular 'sticking point'.

One other reason for giving a preferential treatment by allowing a lower B/C cut off point would be to encourage road controlling authorities to carry out safety audits. It could however be argued that safety audits would only be carried out on schemes which had the potential to be accepted ie the B/C ratio was only marginally below the cut off point. Possibly the safety audit revealed no major problems. To overcome these problems of selection of schemes for safety audit it would be necessary to require road controlling authorities to undertake safety audits of a certain randomly selected proportion of their schemes (possibly a form of the Christchurch City, and possibly Manukau City approach where virtually all schemes are audited internally).

This aspect may be marginal to the present study but, in my opinion, incentives to undertake safety audits and record the changes are justified as safety or 'benefit' promoting actions. Some indication of the justification for such a policy could be a desirable outcome of this study. It seems logical that the present selection of schemes by Transit New Zealand based on their likelihood of benefiting from a safety audit not only results in distortions to the design and B/C process, but also makes the assessment of benefits compared to non-audited schemes very difficult.

Notwithstanding the arguments presented above, the first three topics should be included in a questionnaire directed at designers of road and traffic schemes.

10.2 (O4)Contributing to more efficient use of funds

The last two topics under 'Matters of Opinion' (O) are also capable of survey as matters of opinion but theoretically O4 (the more efficient use of funds) is capable of measurement in 'more bang per buck' or better results in improved safety for money spent. It might be possible, for instance, at widely spaced intervals (to ensure statistical significance) to assess the changes in accidents resulting either from safety audit or a result of the passing on of good design techniques to all schemes, audited or not, and compare this to funds expended. If either a decline in 'accidents' in absolute terms or - better - as a fraction of the national total were observed, then funds are being used more effectively.

10.3 (O5) Improved knowledge and data base

In this case it seems likely that knowledge will improve and that more reliable data will ensue even with little or no change to present methods and procedures.

In the absence of unfair bias or illogical interference in the selection and design of road safety schemes, 'things can only get better'.

However, to reap the full benefits of safety audit and be able to assess them, a more formal approach is needed - to the storing and availability of data.

It is not the purpose of this stage 2 report to actually design such a data base but to present arguments which could lead to its creation. Quoting from a report investigating casualty savings in Surrey (G. M. Lamb, 1995?):

'A computerised database of all RSA (Road safety audit) sites has been set up using a Windows based Geographic Information System (WINGS). This enables all of the sites to be monitored for accidents. Accident information can be easily retrieved, as the whole of Surrey County Council's accident system is also on a WINGS database."

In the New Zealand situation, the Land Transport Safety Authority operates and maintains a national accident data base which utilises national DOSLI coordinates to identify each crash location. Information is being sought from Surrey and it does not seem an impossible or even difficult task, at this stage, to adapt the LTSA system to accept and provide monitoring service for all safety audited locations.

Such a database would be extremely useful in checking on the direct benefits of safety audit (see M1). It could also assist with other objectives such as the performance of schemes from the financial and retrospective B/C points of view.

10.4 (06) Contributing to the function of networks from the traffic calmness and environmental points of view

This 'benefit' has been included after a study of the material from SWOV, the Institute for Road Safety Research, The Netherlands.

The system being adopted in that country and throughout the European Community is to apply traffic calming (Road Impact Assessment - RIA) to roads in various network types and configurations, but including all types of road, not simply main network roads.. This parallels an Environmental Impact Assessment (EIA), once again for the whole network.

The combined effect of these assessments is not only to reduce injury crashes but to improve the 'quality' of the network from the environmental point of view.

These methods prompt the thought that traffic calming is not only a technique in its own right, but also grist to the mill of the safety auditor. It is possible - likely even - that given knowledge, safety auditors will not only address the immediate 'traditional' safety concerns but also the safety to the whole network conferred by traffic calming. They will incline to look for 'rat runs' and opportunities to incorporate thresholds and traffic calming on the network within the area of influence of the major scheme they are auditing.

At the very least, we need to include benefits of safety audit which include the techniques of traffic calming and confer not only safety benefits but also benefits in environmental, social, and land use support terms. The point is, perhaps, a little subtle, but is one that will become increasingly important as whole networks are tackled.

Furthermore, the SWOV or European approach is said to support the concept of sustainability; a very New Zealand concept, having the Resource Management Act to bolster the principle of sustainability.

11. CONCLUSIONS

Not all of the goals or methods described in this report would necessarily be worth the cost or effort, but most offer enough promise to be worth a trial approach. If better knowledge of the benefits of safety audit is to be achieved then the project offers the best chance of success at present.. If current records and systems are inadequate to determine and record the benefits, then the project should assist in correcting these deficiencies. It seems certain that improved data and knowledge about safety audit will lead to more efficient use of the techniques. This in turn will lead to a safer roading system and help achieve national and local goals of crash and injury reduction.

There will always be a limit to what can acceptably be applied to the infrastructure, otherwise separation of different travel modes, electronic speed control, crash barriers universally used, traffic free city centres, the wider use of traffic calming, use of public passenger transport as a compulsory alternative etc. would make dramatic inroads into the accident rate; but at an horrendous cost which the community is unwilling to pay.

It seems likely therefore that the proper application of safety audit will provide a good return for the cost and effort in reduced crashes and injury.. If this project can demonstrate that fact the project will have boosted confidence in safety audit and probably expanded its use. If benefits in others areas can also be demonstrated the there is further support for the wider use of the technique.

12 RECOMMENDATIONS FOR FURTHER WORK ON THIS PROJECT (STAGE 3)

1. That a data base be set up related to the LTSA accident record system. That further information be sought on the Surrey system and the work being carried out in the Transport and Road Research Laboratory of the UK Department of Transport.

2. That at least three Transit New Zealand safety audited schemes and three non-audited schemes be investigated on a trial basis in the central South Island area using the methods described in section 2

3. That the sampling methods and number of studies to give statistical significance be discussed with persons having the requisite skills. That the broad range of methods be discussed with the peer review group which met on a previous occasion, before embarking on the trial studies. (This could have the useful effect of motivating people to cooperate and assist the project).

4. That in conjunction with persons having the requisite skills a questionnaire be drawn up and trialed, to seek opinions about the influence of safety audit amongst designers and others who could be affected by the process.

5. That Studies bear in mind the other benefits listed and ways of achieving the confirmation or rejection of the hypotheses be worked on as the study progresses. In particular, overseas contacts will be kept in touch to obtain any useful inputs that they may have. That in turn we send them information on our studies, including the study of safety audits of urban and rural intersections.

6. That as far as possible financial benefits and costs be assessed. (This may be facilitated if typical accident rates resulting from given features or the lack of them, can be ascertained.)

If the above topics yield positive results, the following should be considered as long term studies, following stage 3 of this project:

7. Depending on the outcome of the trial and discussions about statistical methods, a method be selected for wider study.

8. That if the trials be found to be satisfactory a wider group of roading schemes be surveyed